Earth Science

Rockhounds' NATIONAL Magazine

HISTORICAL MARKER
Early Iron Furnaces of Pennsylvania
(See page 9)

35¢

August Issue, 1958

WILMINGTON COAL FLORA

by

GEORGE LANGFORD

This volume is a compendium of over 350 pages which describes and illustrates all known species of Pennsylvanian Coal fossil plants found in the Wilmington-Coal City-Braidwood strip mining area of Northern Illinois, the outstanding region of the world for these particular fossils.

This book contains approximately 600 diagrams and photographs. Much of the information assembled by Mr. Langford during a lifetime of research is unique and will not be found in other texts.

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Editor's Memo Pad

VACATIONS!! What to see,—when, where, and how: As we greet our friends when they return home from their vacations, we expect to get a great variety of answers,—some ludicrous, and some serious. Of course one of the first questions we will probably ask, after the perfunctory,—how are you; will be what did you see,—did you learn of anything new?

One frequently hears such replies as,—my but we are glad to get home to rest up; or, we had to come home when we ran out of money. More often than not this is true, and what a pity. Some attempting to see how many miles they can drive in a few days' time, will see very little, aside from the center of the highway, the motels and places where they have eaten, perhaps an occasional picture show or two, and will really be glad to get home again where living is easier,—and cheaper.

On the other hand, others, especially the "out-of-doors," or the "rockhound" variety, will come home completely relaxed and refreshed, ready and eager to get back on their job again, looking forward towards another equally good time next year. What, you will say, is the difference? This, we would say, is their objectives. Pardon, if we make a little analysis, some comparisons and likewise a few suggestions. They are all well intended.

On the one hand, there are those who really have no objectives, who do no particular planning and whose principal ambition is just to get out of town for the time being. Then there are those just the opposite, who plan their vacation trips meticulously, sometimes for years in advance, who have prepared an inflexible route, with a rigid time schedule set up almost to the hour. They may have a long list of "musts" to be seen, which they will check off as they go, almost like a doctor making his calls. They are the kind who will evaluate their trip principally by the number of things they have seen, if only at a glance.

Conceivably, volumes might be written upon such subjects as planning a vacation, (see your newspapers),—but we shall not attempt to belabor the question. Every experienced "rockhound" knows fully as well or better than we, what is best for himself and his family under the circumstances. Remember, however, it is always well to keep both your itinerary and your time schedule very flexible. As a rule avoid planning to be at a certain place or to meet some one at a given time or hour very far in advance. The reason for this is obvious. Always be willing and content to change your prearranged plans when and if necessary, and be aware that some of the things and places which have been much "whooped up," for commercial and other reasons may prove to be very disappointing, while others near at home, that perhaps you may never have heard much about, may be very worthwhile.

Having all this in mind, we have planned at least two articles in the present issue of *Earth Science*,—"Early Iron Furnaces of Pennsylvania" and "How High Can You Get" for those who may find it convenient to make use of them. Happy vacation, and don't forget your U.S.G.S. maps, your Guide Books, Federation Membership Directories, —and your driver license,—so long for now.

* * *

VISIT THE ZEITNER MUSEUM: A call at this very outstanding and unique Museum, located on U.S. Route 18, at Mission, South Dakota, should be a "must" for anyone traveling through the West to the "Bad Lands" country, the "Black Hills" and beyond.

It is operated by our charming, talented and much travelled authoress, Ruth Culp Zeitner and her husband, whose father established the Museum many years ago. It is open free to the public, daily and evenings from May to October, and will prove a delightful surprise to all who stop to visit it, —a decided contrast to this otherwise drab and somewhat barren countryside across the plains of the Dakotas.

The Zeitners also are competent authorities on Dakota minerals and collecting, and their very helpful advice is cheerfully given. In addition they operate a fine modern Motel and tourist camp, making Mission a very pleasant stop-over place for the night.

* * *

Our Authors: Bernard W. Powell who has written so interestingly of the "Early Pennsylvania Iron Furnaces," is a member of the National Association of Science Writers. A previous article by Powell on "Fossil Diatoms," in our March-April 1957 issue, was of exceptional value. Incidentally he has recently been appointed Science Editor for Funk and Wagnalls encyclopedia. It is indeed an honor to publish his contributions.

NOTABLE LITERARY ACHIEVEMENT: The unveiling of George Langford's new book, "Wilmington Coal Fossils," which occurred at the regular monthly meeting of ESCONI, in Downers Grove, Illinois, on Friday evening, June 13th, 1958, was indeed a splendid example of all-out cooperative effort on the part of several interested parties.

The author, an 1897 Yale graduate of the Sheffield Scientific School, labored practically a lifetime on the preparation of this most helpful and authoritative compendium of the Coal Measure Fossils of the famous Mazon Creek area. Its 350 or more pages record an outstanding piece of research work not published elsewhere,—a most valuable contribution to the science of Paleobotany.

The publication of the book was sponsored by an enthusiastic group of local Earth Scientists, working together as the ESCONI Associates, who in turn were also aided by the Midwest Federation, of which the Earth Science Club of Northern Illinois is an affiliate. The project will be financed by the sale of 200 First Edition de luxe copies, autographed by the author at $20.00 per copy, and ordinary Second Edition cloth bound copies for a lesser sum. Those interested should secure their copies immediately, while they last, sending their order to Mr. Harry C. Witmer, 5303 Victor Street, Downers Grove, Illinois, who is chairman of the project.

* * *

THE PALIMPSEST: Ye Editor "Wilson" was delightfully surprised to find all five of his Iowa Meteorite articles, which had been printed earlier in scattered issues of The Palimpsest,—monthly magazine of the State Historical Society of Iowa, republished as a single issue as of April 1958. These stories describe graphically with illustrations all four of the great meteoric showers of Iowa, and also one "find" which was a noteworthy contribution to the science of meteoritics.

Anyone interested in this unique phase of mineralogy, may obtain a complete copy, postpaid, 60 pages with illustration, for 25c, from the Society,—address Iowa City, Iowa.

* * *

We've lost a friend: Midwest members were saddened to learn of the death of Past President George Anderson, on May 15th, 1958, at his recent home in Sister Bay, Wisconsin. He served as Federation President during 1947-48. For many years before his retirement he was employed by the Chicago Park Board in various capacities, and more recently as coordinator and instructor of the Park District's Lapidary Work Shop projects.

Midwest Club News

BERNICE REXIN, *Club Editor*

Kalamazoo Geological and Mineral Society on May 5 heard Roy D. Pixler, certified gemologist and registered jeweler of the American Gem Society, present a talk on "Increasing Your Gem Stone Appreciation." Mr. Pixler stated that a gemologist does not consider a stone's color or use a scratch test when he is identifying it, but checks to see if it is single or double refractive and uses index and specific gravity tests. Mr. Pixler also showed slides on the mining and cutting of diamonds, and on fashions in jewelry.

Des Moines Lapidary Society recently enjoyed a talk by Winifred Jones on Iowa Geodes. Members also displayed and discussed their favorite geodes.

On April 15 DLS was the guest of the Mid-Iowa Rock Club of Marshalltown, Iowa. The host society put on an amusing skit concerning minerals and then held a rock identification contest. Rocks were given as prizes to the contest winners. Two films were shown, the first on the processing of aluminum and the second on the desert in bloom.

Central Illinois Rockhounds held a picnic on June 8 at "Research Acres," the home of Mr. LaFayette Funk. After lunch the group enjoyed a lecture by George Wilson, of the Illinois Geological Survey, on "The Practicability of Paleontology." They were also shown Mr. Funk's extensive collection of rocks and minerals.

Indiana Geology and Gem Society made an overnight trip to Flint Ridge Memorial Park, Brownsville, Ohio on May 17-18. Digging for flint in the State owned park is prohibited but Flint Ridge, which is 2 miles wide and 25 miles long, provides plenty of digging areas outside of the park. The colorful flint can be picked up from the surface but the best specimens are found underground. The group collected as much flint as they wanted. The need for safety glasses on rockhunting expeditions was illustrated by the fact that one member of the party had one of the lens of his glasses ruined by splinters of flint that were sent flying by his rock hammer.

Non-Profit Organizations are not relieved from filing income tax returns and paying the tax unless a Commissioner of the United States Treasury Department has determined that they are exempt. Accordingly every organization that claims to be exempt from income tax under Section 501 (a) of the Internal Revenue Code of 1954 and corresponding provisions of prior acts, should obtain form 1023 from the Bureau of Internal Revenue and furnish such information and data as specified therein, together with any other facts deemed material to the question, to the Bureau with the least possible delay, so that the Commissioner can determine if the organization is exempt.

Central Michigan Lapidary and Mineral Society on May 18 made its second visit to Pugh Quarry near Weston, Ohio. Members found an abundance of double terminated calcite crystals up to three inches long, barite, some fluorite, and trilobites about an inch long.

St. Louis Gem and Mineral Society reports that streaks of tiny diamonds have been found at a depth of 180 feet in a quarry near Jerseyville, Illinois. Laboratory tests have shown that the sparkling specks present in a strata of soapstone are diamonds. This strata is 30 feet below the present working level of the limestone quarry and the diamonds were discovered during the drilling of a sump hole. Seventy feet below this strata is some unknown material that is so hard it ruins the drills!

Michigan Mineralogical Society on May 12 heard an interesting and informative lecture on Australia and Australian opals. The speaker, Dr. Russell Boyd of Toronto, Ontario, once lived in Australia and had first hand knowledge about opal mines.

MMS urges its members who are taking rockhound vacations to do the following: (1) Enjoy themselves, (2) Be careful, (3) Get plenty of super-duper specimens, (4) Collect some for the society's auction, (5) and bring back good stories about their experiences.

Cincinnati Mineral Society on May 28 heard Frederick Hauck, President of the Continental Mineral Processing Corporation, speak on the "Potentialities of Mexican Minerals." His illustrated discussion concerned the mining operations of his company in Sonora, Mexico and the problems involved in mining tungsten, iron and copper ores. Specimens of these minerals were exhibited. Mr. Hauck's warm personality and animated stories, along with his descriptions of mining operations and workmen, made this a very interesting program.

Field trips taken by CMS this spring were one and two day excusions to Flint Ridge, Ohio for colorful flint (sometimes called Ohio agate); Portsmouth, Ohio for catlinite (pipestone); and to quarries in the area of Salem, Mount Vernon, and Mitchell, Indiana for geodes, calcite, sphalerite, selenite and pyrite.

Flint Rock and Mineral Club supplemented the May issue of its Newsletter with "Mineralogical Guide," a publication prepared by Robert Kelley for the Michigan Department of Conservation, Lansing 26, Michigan. This booklet lists Michigan mineralogical societies, Michigan museums exhibiting minerals and fossils, and an execellent introductory discussion of mineralogy as a hobby. Anyone who is interested in minerals and resides in or plans to visit Michigan will find this publication worthwhile.

Earth Science Club of Northern Illinois on May 9 heard Charles Wyman, an industrial hygiene and safety engineer, discuss "Radiation Hazards After Nuclear Explosions." Mr. Wyman has made an extensive study of fallout hazards and recently, in response to a request from the White House, attended the President's conference on occupational safety. Following Mr. Wyman's talk, a sound movie, "A is for Atom," was shown. This movie was loaned to the club by the General Electric Company.

Wisconsin Geological Society at its May meeting heard James Bigelow lecture on "Sphere Cutting." Mr. Bigelow told how he cut spheres and showed spheres in various stages of completion. He displayed the equipment that he uses in cutting and polishing spheres. It takes Mr. Bigelow about 20 hours to complete a sphere.

Other Societies

Miami Mineral and Gem Society recently viewed a historical colored film on the 1939 Byrd Antarctic Expedition which was devoted primarily to the investigation of the mineral resources of that area. Colonel A. T. Petros, of the United States Marine Corps, who showed and commented on the film, also displayed an interesting array of minerals from the Antarctic.

Northwest Federation of Mineralogical Societies 1958 Convention will be held August 30 to September 1 in the Pasco Senior High School, Pasco, Washington. Among the special exhibits will be a priceless collection of 125 meteorites, ranging in size from 10 grams to 91 pounds. Some have been cut in half to reveal their interiors. At nearby Kennewick, Wash., Mr. and Mrs. Gordon Maxey will hold open house so that visitors may see the beautiful living room floor, fireplace, tables and book ends that Mr. Maxey has made from lovely petrified wood and other gem materials. The show committee will be glad to give out of town visitors suggestions for places to see and things to do. There will also be field trips.

American Convention: The Midwest Federation was signally honored recently when our own Hazen T. Perry of Minneapolis, Minnesota and former president of the Midwest was elected president of the American for the coming year.

The Texas Federation is to be highly congratulated upon putting on one of the largest and finest mineral shows ever to be held anywhere in the country. The annual meeting of the American held in conjunction with the Texas conclave in Dallas, Texas beginning on May 2nd, was presided over by Vincent Morgan of Boron, California, and was orderly, constructive and went off exactly according to schedule.

The new officers elected to serve during the coming year were,

Mr. Hazen T. Perry, President,
Minneapolis, Minnesota.

Mrs. Helen M. Rice, Vice President,
Hillsboro, Oregon.

Mr. Henry B. Graves, Secretary,
Miami, Florida.

Mr. James F. Hurlbut, Treasurer,
Denver, Colorado.

Dr. Ben Hur Wilson, Historian,
Joliet, Illinois.

Mr. Dwight Halstead, Regional Vice President, Dallas, Texas.

Mr. Lowell Lovell, Regional Vice President, San Francisco, California.

The 1959 Convention of the American Federation will be held in Portland, Oregon during the Oregon State Centennial on September 5th, 6th and 7th of that year.

* * *

Dates To Be Remembered: A number of important events are still on the 1958 Calendar which we would like to call to the attention of our readers. They are here listed and we recommend your attendance.

Aug. 7, 8 and 9. *Eastern Federation of Mineralogical and Lapidary Societies.* Annual Convention and Show. City Auditorium, Asheville, North Carolina. Southern Appalachian Mineral Society, host.

Aug. 30, 31 and Sept. 1. *Northwest Federation of Mineralogical Societies.* 18th Annual Convention and Show. High School Gymnasium, Pasco, Wash. Lakeside Gem and Mineral Club and Associates, hosts.

Sept. 20 and 21. *Long Beach Mineral and Gem Society.* Gem and Mineral Show. Women's City Club, 1309 E. 3rd, Long Beach, Calif. 20th, 10 a.m.-10 p.m.; 21st, 10 a.m.-6 p.m.

October 18 and 19th. *Des Moines Lapidary Society.* "Rockhound Roundup." More than a Club display,—less than a convention. Gem and Mineral Show. Veterans New Auditorium. Open to all without charge.

Mineralogical Society of Arizona on May 16 listened to Archeologist Odd S. Halseth trace the importance of minerals to human culture. Paleolithic Man, Professor Halseth said, learned to chip sharp edges on the stones he used to obtain food and to affix handles on his bludgeoning tools, thereby making his life a little easier. Neolithic Man extended this development by smoothing and shaping materials about him to adapt them to his use. He cultivated crops, domesticated animals, built homes and fought with these more convenient implements. With each new technological development man increased his leisure time, and today, after 50,000 years, he has attained a 40-hour week. People, Professor Halseth pointed out, are always looking for new mineral resources to support their technology and anything that helps mankind is intrinsically good; misuse is not the fault of the mineral. The eleven basic minerals required by the soil to produce food are the most important to man; he could continue to exist without the "push-button" elements that make his life comfortable.

Colorado Mineral Society gives the following tips for safety in the field: 1. Don't go into rough areas without leaving word of your being there and your expected time of return. 2. Know where you are and take sightings to keep your landmarks in view. 3. If you should get lost or hurt, DO NOT PANIC. Stop and analyze your position and, if hurt, your physical condition. Try to locate shelter and water, and if you move on leave good signs behind you to aid anyone who is hunting for you. 4. Carry plenty of water. Do not drink from unknown water sources and use water purifying tablets. 5. Wear a hat in the hot sun and use your sunglasses. 6. Wear good boots with high tops to protect your ankles and legs from scratches, snakebites and turns. 7. Carry a first aid kit, and wear safety goggles when pounding on rocks. 8. Don't go into abandoned mines and pits. 9. Camp on high ground; flash floods are dangerous. Shake out your boots in the morning if you are in scorpion territory. 10. In snake country, look first and be alert. Watch where you put your hands and be sure to check a crack or crevice before reaching into it. Don't step into thick brush without testing it for snakes. Sleep on a cot or something off the ground; snakes love nice warm sleeping bags and will crawl into bed with you. Snakes are seldom seen at altitudes above 7,000 feet.

Early Iron Furnaces of Western Pennsylvania

by BERNARD W. POWELL

MINERALOGISTS who would combine a little adventuring with their field collecting will be rewarded by a visit to some historic iron furnaces in western Pennsylvania. About 70 miles north of Pittsburgh (as that proverbial crow wings it), is the town of Franklin in Venango County (see map). A ten-mile radius swung from Franklin as a center encompasses the sites of more than half-a-dozen early 19th century furnaces. These interesting relics mark the region where one of our country's mightiest mineral-based industries arose: the iron industry. Collectors can find beautiful pieces of colored slag near most of the old ruins, and within very short distances are bog iron ore deposits where nice specimens of limonite and "honeycomb" bog ore can be taken. Transportation difficulties 125 years ago dictated that both iron ore and limestone be near the actual site where smelting was to be done; limestone quarries still abound throughout the general region.

And how!! Early Iron Furnace in operation.

Off Travelled Roads

Many of the furnaces are some distance from travelled highways and can only be reached on foot after traversing some really rough terrain. Those situated in woodland tracts rather than open fields, are often camouflaged by vines and underbrush and are exceedingly hard to spot even when you are quite close upon them. A few of the old furnaces are near to roadways—and generally, these have suffered the most, with the erosive effects of time and weather being abetted by generations of pilferers who have stripped the cut stone facings from many of the old stacks. One of the best, the Victory Furnace, still stands well-preserved—though remote from any road—and must look substantially as it did years ago when the forests rang with the noise of woodcutters chopping trees for fuel, and the stone stacks daily poured forth "fire against the sky."

The native Colonial iron industry really had its inception on the banks of the Saugus River in the Massachusetts Commonwealth in 1643.* Prior to that time, all ironmongery was brought over from the Old World; there were no primary smelters—or furnaces as they were called—in the Colonies. The Saugus venture gave the Colonials their first iron from local sources.

The story of the Saugus works has recently been greatly illuminated by combined efforts of archeologists, geologists, engineers and historians who have excavated and restored this first site of the iron industry in our country as a permanent shrine for all Americans to enjoy.

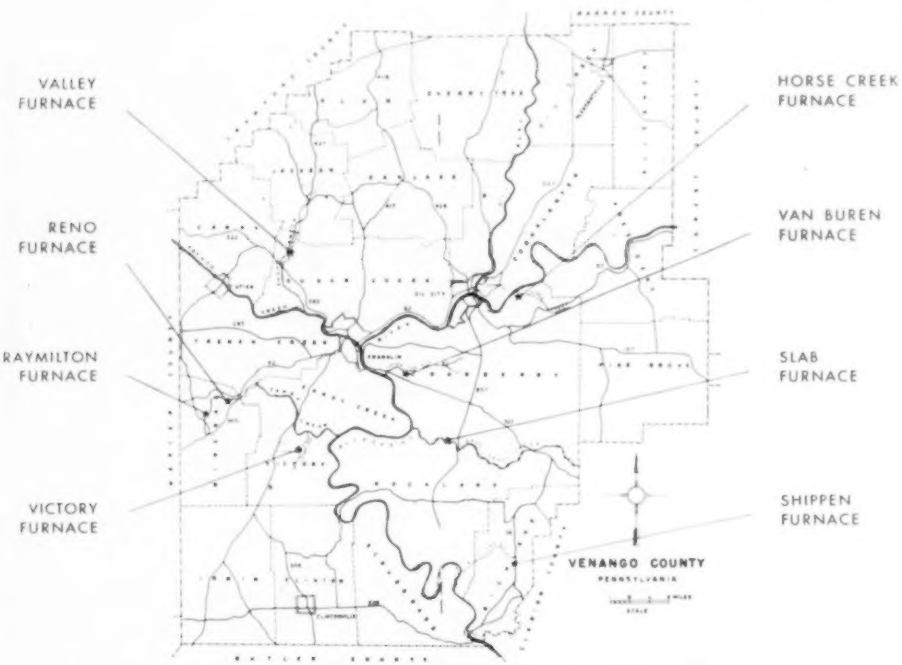
*(See Nov.-Dec. 1954 Issue of Earth Science: "Saugus Restored".)

Less well known than the Saugus works are the obscure furnaces in western Pennsylvania, that were ultimately perhaps, more important than the Saugus operation. For with the passing of the Saugus works, Massachusetts ceased as an iron producing region—but Pittsburgh to this day is our "steel city" and received its first pigs of iron from some of the furnaces to be described.

Just when the first furnaces were constructed in Venango County is perhaps open to question; certain it is that most of them were in operation during the first half of the nineteenth century—and it is just possible that several early ones furnished iron for use in the War of 1812.

molten ores, and 3) extensive forests for utilization as charcoal fuel. Many places in the colonies had one or two of these conditions but not many could meet all three. Western Pennsylvania did, and it was here that a flourishing smelting business arose.

Usually a group of venturers would go together pooling their resources, to construct a furnace. It cost somewhere around $20,000 to build one of these structures—and as "cash" loans were relatively unknown to our ancestors, you can see that such an undertaking was somewhat of an event. The furnaces were usually built of nicely cut stone and selected fieldstone slabs. These were layed up either



Map: Location of Early Iron Furnaces of Western Pennsylvania. ***Prepared by Author***

Strict Requirements

Only fortuitous geological conditions could encourage erection of a furnace in the early days. The circumstances required for profitable operation were namely three: 1) a nearby source of bog iron ore—or more rarely mined ore, 2) local limestone for fluxing or cleaning the

in stepped courses or else courses flush-surfaced but tapered back towards the top. The insides were faced with soft stone built up in the form of a cone. An opening was left in the bottom of the furnace for access to the interior when patching—and to let out the stream of molten iron. This was channeled into a gutter or main feeder ("sow") and thence into little side gutters ("pigs") to solidify. These latter pigs were the actual iron ingots desired and were broken off the main feeder and shipped by wagon or boat to ironsmiths and other tradesmen down in Pittsburgh. This, incidentally, is the origin of the phrase "pig iron" from the allusion to all the side gutters sticking out from the main gutter—for all the world like so many suckling piglets at a brood sow's teats.

A shed usually housed the gutters where they issued forth from the furnace; at most sites all evidence of these small temporary structures is long vanished. Furnaces had to be built next to steeply sloping hills in order to permit charging. A bridge was constructed out from the side of the hill to the top of the furnace, and over this the workers trundled barrows loaded with ore, charcoal and limestone and dumped them directly down into the furnace. With luck, a typical furnace charge would yield somewhere around three tons of iron a day.

Somewhere in the vicinity of nearly all the furnaces had to be a bog iron ore deposit. We moderns may disdain the use of such low-grade ore from which to secure iron—smug in our technology and the seemingly inexhaustible resources of Minnesota's Mesabi range. But those hardy forefathers of ours dug limonite ores in local swamps and bogs and carted it to their furnaces. It was hard work and the ores had many impurities—but from them were forged tools and guns that convinced many ambitious European tyrants that here was a nation of clever and industrious craftsmen determined to pursue their own destiny—and who knew full well how to make the weapons and mechanical items they needed to realize this aim. . . .

Fields and woodlands around the sites of the abandoned furnaces contain bits of slag, dating from the days when the furnace was in operation. Occasionally round deposits of charcoal and soot are turned up during spring plowing to disclose spots where beehive coke ovens were constructed for baking the native hardwoods. The ancient ore "diggings" still harbor mineral specimens. Every representative collection should contain some iron ore species—what better than a specimen from the rugged countryside that harbored the infant American Iron industry?

Victory Furnace: A typical ruin, well preserved. —See text.

Mineralogy of Bog Iron Ore

As a mineralogical aside — certainly not amiss here—it is interesting to note the nature of bog iron ore itself. More generally known as limonite (actually a somewhat ambiguous term), bog iron ore is a "hydrous ferric oxide" with the impressive chemical formula of $2Fe_2O_3 \cdot 3(H_2O)$ and ordinarily takes stalactitic, mammillary or earthy forms. It is dark brown in mass and characteristically yellow-brown, as a powder. Another name for this mineral substance is "brown hematite"; those with chemical backgrounds will appreciate the relationship between limonite and hematite. Most ochers are limonite. Impurities are common in the ore, and perhaps reflect on its origin, for bog iron ore is always a deposit of secondary origin. Iron-rich minerals weathering at the surface produce limonite. It commonly occurs as either an inorganic precipitation in water-laid deposits, or as a biogenic deposit laid down through the ceaseless activity of many types of micro-organisms in swamps and bogs. This fact that it can be laid down by living beings gives the mineral a somewhat unusual distinction, because not too many mineral deposits ordinarily result from organic agents. The very word "limonite" comes from the Greek word for meadow *(leimon)*, and is an allusion to the observed fact of its occurrence in bogs and swampy places.

Many ironworks in eastern Pennsylvania relied on the mines at Cornwall to supply ore—and this was a relatively good grade magnetite ore. But in the hilly, wild interior of the western part of the state, it was the carbonated and inferior bog iron ores that supplied the furnaces—mainly because of greater accessibility.

The Furnaces

The Victory Furnace: Because it is the hardest to reach, the Victory Furnace probably still stands as the best preserved of all the old furnaces. Situated on Victory Run, west of the Allegheny River, the Victory stands well nigh as perfect as it did 110 years ago when it was built, with the exception of a crack which extends the full length of its face. It is 25 feet square at ground level and has 32 courses of cut stone. These carry it on a slight taper to a height of 35 feet. There is a cap stone over the main opening and it was 10 feet long before the crack developed. It is 15 inches thick, and evidently the furnace builders were proud of this particular job for they put a bevel on the edge of this stone. At the bottom, the front opening is 10 feet wide and it rises to a height of 9 feet—narrowing a bit towards the top. Near the top of the stack, an offset in the back wall indicates where the charging bridge from an adjacent high bank was anchored. Power for the blast at Victory—as at many of the old furnace sites—was furnished by partial diversion of a nearby streamlet (or "run" as they are called in

Valley Furnace: Base only remains intact.

that part of the country), which was utilized to turn a wheel.

The furnace was originally built in a heavily wooded section and the forest has reasserted itself and again taken over. Ferns and saplings sprout from the very face of the furnace wherever seeds have managed to take root in cracks and seams. The ties for the narrow gauge road which served the Victory at the height of its operation, lie green and mouldering in the forest floor. They are yet visible, though heavily covered with moss. Wrought iron spikes can be dug out almost anywhere along this old roadbed.

ining its surroundings and how the operation was conducted. Almost anything which applies to operation of one furnace, is true in general for the others.

It comes as a shock to forest lovers and conservationists that a typical furnace like Victory could exhaust from 100 to 200 acres of woodland in one year's running! Trees were cut in six-foot lengths and stacked on end around a small open fire hole. Such stacked wood might cover an area, say, 25 feet in diameter. This was all then enclosed in a beehive oven, a central fire was lighted, and the ground opening closed. Within four to ten days a

Shippen Furnace: Example of badly ruined remains.

"bake" was completed, and taking special care when opening the oven (a vagrant breeze might suddenly fan the charcoal and ignite it), the workers took out the resultant coke and stacked it in special high-sided wagons and hauled it to the furnaces. It took 1200 bushels of charcoal a day to fire up Victory for an average three-ton run. . . .

Alternate bushels of charcoal, ore and limestone were charged down the flue of the furnace before and partly during the melt. Slag (mostly silicates and carbonates) floated up on top of the heavier iron

There were three "workings" that furnished the bog ore for Victory. One of these is a bed of honeycomb ore formed by leeching. The stratum so-produced is bog ore over an area of three to four acres in extent and from two to six feet thick. It actually grades in all shades from red to yellow, and the red deposit is said to have been recently used as pigment material for a cosmetic line.

"Victory" is a typical and well-preserved example of the western Pennsylvania iron furnaces, so perhaps we can profitably spend a little more time examwhich dripped down to collect on the hearth. The furnace was tapped about twice daily to get this molten iron. Such a furnace as Victory was usually kept "in blast" continuously for about nine months out of the year and then closed down for three months to effect repairs. At the height of its use, Victory Furnace was one of 17 furnaces "in blast" in this area and together they produced about 12,000 tons of pig iron a year. At that time the price was about $32.00 per ton. Being within just two miles of the Allegheny, most of Victory's output was shipped to Pittsburgh by water.

Horse Creek Furnace: Near where Horse Creek joins the Allegheny, stand the remains of another furnace. It was built of cut stone and was square at the base. The furnace is still in good repair and most of it is yet intact. Fire scarred stone, which constituted the lining of the furnace, can still be plainly seen in the center stack. Old records indicate that ore for the Horse Creek operation was obtained from four nearby mines and that the furnace operated for about 18 years. A short history of the furnace has been posted by the present owners, for those interested in the story of early iron.

Old Shippen Furnace: Not far from the headwaters of Mill Creek stands the greatly ruined stack of another old furnace. Most of the surface stone has been lost, but the stack still extends to its full height and shows the conventional upwards taper. One recent eyewitness of the ruin says of it that it "stands in an open pasture and looks like a huge milk bottle built of stone." Erected in 1850, it carries the scars of long service; raccoons now prowl nightly about it and birds nest undisturbed in the stack.

Valley Furnace: Built around 1846, and run at a profit for nearly six years, the old Valley Furnace was made of dressed stone and was circular in shape. A unique feature here is presence of four triangular openings at the base. Fair-size trees growing from the top prove its long abandonment; the local D.A.R. chapter has placed a marker on the furnace in an effort to keep alive interest in the relic.

Van Buren Furnace: Pretty pieces of colored slag abound near the remains of this old stack which once streamed sparks and sulphurous fumes into the bright Pennsylvania sky. It was operated for 15 years. The old Van Buren has been unkindly treated by time since its erection in 1836 on Lower Two Mile Run. However, the center stack still stands in rough stone. The outer facing stones, of course, are long since gone. The stack, though broken quite badly at the top, appears to reach to its original height.

Slab Furnace: Almost a total ruin, Slab Furnace is perfectly camouflaged near the edge of a heavily wooded spot. You have to know where to look to find it. Pieces of slag scattered over the surface of a nearby plowed field attest to the smelting activity here. Black spots abound where charcoal ovens stood. A man named Samuel Cross built the furnace back in 1852. His idea in construction was to dig a circular trench to delineate the base and then erect posts two feet apart and 20 feet high. These were lined on the inside with stone slabs, and this original way of building gave Slab Furnace its name.

Clay Furnace: Between Mercer and Sharon on U.S. Route 62, is a highway marker indicating a side road leading to the ruin of Clay Furnace. The marker (see) explains the import attached to the site, but Clay Furnace is more decayed and broken than almost any other site. It is located at the edge of a pasture, close to the conventional charging hill. Time and stone-mining have worn away its sides so that it now looks like a pile of rocks overgrown with grass and weeds. The cone has been filled with stones and dirt, but at the top of this mound, two courses of the inner lining are yet exposed and are circular in shape—just as when they were laid up. Their burned and blackened surfaces are a tribute to the fires of young industry which burned so brightly in these hills a hundred years ago.

Epilogue

Unknown to most, and almost inaccessible in many cases, the old iron furnaces of western Pennsylvania moulder slowly back into the ground from which they sprang. The breaking forces of growing roots and the buckling of frost will slowly topple the old stacks and someday the underbrush will have completely obliterated any surface evidences of many of these interesting old sites. Those who find pleasure in the outdoors, in perhaps collecting a nice mineral specimen or two along the way—and who would contemplate in peace the humble beginnings of one of America's great industries, may find a side trip to one or more of the old furnaces an enlightening venture.

* * *

Book Reviews

PHYSICS AND CHEMISTRY OF THE EARTH. Vol. 2. Pergamon Press, 1957. $10.00. Ahrens, et alii, Editors.

The wide field covered by the geophysical and geochemical sciences is seldom realized by the average scientist. The I.G.Y. has served to bring many of these activities to the attention of the general public, and to other scientists, and to show their relation to the more conventional fields of physics and chemistry.

The current Volume II, of the series "Physics and Chemistry of the Earth" is written with the view of presenting the latest developments in this field to scientists in general and to lay public who may be interested in the more technical details, which are omitted from popular descriptions. The subjects chosen for this volume include oceanography, studies of data on the abundance of the elements, theories of the origin of the solar system, and studies of the Earth's latitude variations. Each chapter has been written by a specialist in that particular field, and presents the latest developments and theories. Extensive bibliographies are included in each chapter.

—Emerson Pugh

* * *

"EARTH FOR THE LAYMAN": A book which every rockhound should have on his desk, containing a list of nearly 1400 good books and pamphlets of popular interest on geology, mining, oil, maps and other related subjects. Published by the American Geological Institute, 2101 Constitution Avenue, N.W., Washington 25, D.C. Price $1.00 postpaid. We recommend it for big value.—Ed.

Know Your Minerals

by JOHN S. ALBANESE

MOST mineral collectors go through life assembling large collections of colorful minerals—without ever having tested a single specimen. Often these collections contain suites of locally found specimens, some of which may be of scientific value when studied by a trained mineralogist.

Sometime ago I acquired an old collection, with some specimens collected more than a hundred years ago. Of course, many specimens were mislabeled. One of these was labeled "erythrite—Langban, Sweden." When I first picked up this specimen, its "heft" told me it was not erythrite, for erythrite is a relatively light mineral, while this specimen was as heavy as galena (gravity 7.4). I proceeded to make some tests. I knew it was not a carbonate, for carbonates are not quite so heavy. Next I powdered a fragment of this mineral on a charcoal tablet under the blow pipe flame, and I got no reaction (fumes) for sulfur or arsenic; so I knew it was not a sulfide or arsenide mineral. Next I fused some of the powdered mineral and got a small metallic button, which when dissolved in hot dilute acid, proved to be lead. Now I knew I had a lead mineral which *could* be an oxide.

More of this powder (a tiny fragment at a time) was mixed with powdered charcoal and sodium bi-carbonate (plain baking soda) and fused it before the blow pipe. Next this fused mass was boiled in a test tube partly filled with dilute acid, and when cooled, I added a few drops of ammonium hydroxide to the solution and got a reaction for ferric iron.

By consulting the list of minerals under the element *Lead* in Dana's Textbook of Mineralogy, fourth edition, I found about 130 species with lead as a constituent. By eliminating all the silicates, sulfides, sulfates, arsenides, arsenates, carbonates, I had a few dozen species to consider. Testing the specimen further, I got a gravity of 7.6; a hardness of about 2.5; and rubbing on a porcelain tablet gave a yellowish-red streak. The specimen consisted of lamellar plates with a structure like that of mica, dark red brown in color and with a sub-metallic luster. Dana's fourth edition listed a mineral named Hematophanite, with a chemical composition reading $Pb(Cl, OH)_2 .4PbO.2Fe_2O_3$. Further checking showed this mineral to have the following characteristics: lamellar aggregates of plates, micaceous cleavage. Hardness 2 to 3. Color dark-brown, with sub-metallic luster. Streak yellowish-red. Occurrence—Jacobsberg, Vermland, Sweden.

Dana's System of Mineralogy, 7th edition, lists this mineral as an oxide of lead and ferric iron. As there is no other oxide of lead which even approaches Hematophanite in physical properties, there was no need for further investigation. My specimen is hematophanite, and nothing else. This mineral was no doubt collected about 100 years ago, and is a *one locality* mineral. As the deposit at Jacobsberg is now extinct, and as there is no prospect of this species ever showing up again, it is fair to assume the specimen just described is a very rare specimen. One of the largest museums in the country does not have hematophanite in its collection.

Which points to the necessity of studying minerals, not just admiring them because they are colorful, or beautiful. An unattractive rare mineral specimen may be worth more than an entire collection of common minerals, even though it may consist almost wholly of colorful and attractive minerals. Individuals, or institutions desiring to obtain this specimen of hematophanite may have to part with "their right arm." In other words, a rare mineral is worth what one can afford to pay for it. There is on record an instance where a stamp collector paid $150,000.00 for a rare stamp, a mere piece of paper. No doubt, he had to outbid many other collectors to acquire this rarity.

Identification of a mineral specimen, common or rare, is one of the greatest thrills of the mineral collecting hobby. It is like creating something. All a collector needs to identify his unknown or doubtful specimens are a few chemicals, a blow pipe, a candle or alcohol lamp, some charcoal tablets, a few tablets of unglazed porcelain, and a set of small specimens which constitute the scale of hardness, as talc, gypsum, calcite, fluorite, apatite, feldspar, quartz.

Some good books may help the collector in mastering the art of identifying his own minerals. Books as Frederick H. Pough's Field Guide to Rocks and Minerals, Dana's Manual of Mineralogy, fifteenth edition, by Cornelius S. Hurlbut and Orsino C. Smith's Mineral Identification Simplified are very good books for the average mineral collector.

Until the collector *knows* his minerals, he misses the real pleasure of a truly fascinating hobby.

Hawaiian Bauxite

BAUXITE, due to its great importance as our principle source of metallic aluminum, is always in high demand. Most of the top grade ore deposits in the United States are rapidly becoming exhausted, and were it not for large imports from South America our American aluminum industry would soon be in a bad way. However, this shortage is now to be remedied by new discovery of huge bauxite deposits in Hawaii.

Preliminary estimates indicate there may be over 600,000,000 tons of bauxite in Hawaii, over 10 times the total of all other United States reserves. Legislative action is now being taken to conserve and market these vast resources. There, also may yet be other undiscovered deposits in the States which might be profitably exploited, and a fortune may await their discoverer. For the benefit of the inexperienced or amateur prospector, we publish the following information.

How To Identify

BAUXITE: A hydrated aluminum oxide ($Al_2O\ (OH_4)$), occurring as an indurated (hardened) clay-like mineral, often associated with clay beds, which breaks with a rough uneven surface; light creamish to grayish color, often mottled with darker (brownish) small spots (iron oxide impurities); can usually be scratched with the fingernail, and has a Specific Gravity ranging from 2.0 to 2.6. Bauxite is seldom a true mineral (chemically pure) as it is frequently mixed with other oxides such as gibbsite, boehmite, and diaspore.

An approximate estimate of the quality of bauxite may be obtained by grinding a dried sample in an agate mortar (druggist's) for half a minute. A bauxite of good grade will be found hard to grind and will stick to the mortar with such tenacity that it will have to be scoured out; a poor bauxite or bauxite-clay will grind much easier and will stick to the mortar very little, if at all; and clay or kaolin will grind with ease and will not stick to the mortar.

This property is thought to be governed by the presence of the OH_4 radical in the formula of the bauxite molecule.

B.H.W.

* * *

EMERALD

"As when the emeral green enchas'd
In flaming gold, from the bright mass acquires
A nobler hue, more delicate to sight."

J. Philips

* * *

AQUAMARINE

"Once entire stone of a sea-water green known by name of agmarine."

(Stow Chron. 1598)

* * *

"Blinded like serpents when they gaze
Upon the emerald's virgin blaze."

Tom Moore (Lalla Rookh)

Determining The Age of a Meteorite*

EVIDENCE TO SUPPORT a new theory about the formation of meteorites has been reported recently by three physicists from three different countries who worked together in the Chicago area, at the Argonne National Laboratory, located near Lemont, Illinois.

The scientists are David C. Hess of Downers Grove, Illinois; Johannes Geiss, of Bern, Switzerland, and Friedrich M. Begemann, of Mainz, Germany.

Studying rates of "isotopic decay" of one element to another, scientists have succeeded in establishing the age of the solar system at about 4.5 billion years.

The new theory is that meteorites result from collisions between planets or asteroids comparatively recently in the scale of celestial time. These parent planets or asteroids were formed at about the time of the formation of the earth, the scientists believe. (An asteroid is a small planet-like body which revolves in an orbit around a star, such as the sun.)

Studying meteorites that fell in Norton County in northern Kansas, and Furnas County, Nebraska, which adjoins Norton County, both part of a 1948 meteor shower, the scientists found that the two bits of rock from the sky may well have been traveling in space for 240-280 million years. (A meteorite is a meteor that has fallen to the earth.)

Meteoritics, the systematic study of meteorites, and their attendant phenomena, is comparatively new in the science category, having been developed almost solely within the past century. They are, in fact visitors from outer space, and as such they have brought us much concrete evidence concerning the true nature of our material Universe.

For only a few moments were these bits of rock visible, even with the most powerful telescope, for a meteor does not become a "shooting star" until it reaches

*Argonne Laboratory Press Release

the earth's atmosphere. Friction of the atmosphere produces heat, and the meteor appears to "burn."

Not only had the meteors been traveling for possibly 240-280 million years, the scientists concluded, but each was originally a part of a planet that had been in existence approximately 4.2 billion years before it was thrown into space.

The scientists base their conclusions on studies of the amounts of certain elements within the meteorites and of the radioactive decay of one element to another.

Elements can gradually lose small portions of themselves, releasing particles of energy, decaying into other elements. Uranium and radium, for instance, decay over a long period of time into lead. It is possible to measure the "lives" of these elements by computing the rates at which they decay.

Atoms of potassium-40, an isotope or a species of potassium in which the atoms are of uniform atomic weight composing a small percentage of all natural potassium, decay to produce an isotope of another element, argon-40. By measuring the amounts of potassium-40 and argon-40 in a meteorite, it is possible to estimate the time since the meteorite attained its present mineral form. In doing this, the scientist begins with the known rate of decay of potassium-40 to argon-40, that

DAVID C. HESS of the Argonne National Laboratory, Lemont, Illinois, prepares to admit a sample of argon gas to be analyzed with a mass spectrometer. With this instrument, atoms of the gas are ionized (positively charged). The ionized atoms (called ions) are then accelerated by application of high voltage. The ions of three isotopes of argon, A-36, A-38, and A-40, move in paths of slightly different radii and so can be separately collected and measured. This is in the procedure of measuring the life of the Kansas and Nebraska meteorites.—Photo Argonne Laboratory

David C. Hess at work in Argonne National Laboratory.

is just how much will decay over a given period of time.

Geiss, Hess, and other researchers have tested several meteorites this way, finding that their potassium-to-argon ages are between 4 and 4½ billion years. This is approximately the age of the earth, the moon, and the planets in our solar system. The age of the Norton County meteorite was computed by the potassium-to-argon method to be about 4.2 billion years; the potassium-to-argon age of the Furnas County meteorite was not computed.

Two other isotopes, hydrogen-3 (tritium) and helium-3, gave Begemann, Geiss, and Hess the key to their explanation of how meteors may be formed.

Cosmic rays, found in space, continuously bombard a meteor during its flight. They affect its chemical makeup, producing helium-3 and causing hydrogen-3 to decay to helium-3. Knowing the speeds at which these two reactions proceed under cosmic rays, the scientists were able to compute the lengths of time that the Norton and Furnas County meteorites had been subjected to cosmic bombardment. This turned out to be 240 million years for the Norton County meteorite and 280 million years for the meteorite that fell in Furnas County.

So far evidence indicates that cosmic rays have been constant in their intensity for at least the past one hundred thousand years. If cosmic rays have had their present intensity for about five hundred million years, then according to the three scientists, the 240 and 280 million-year meteor "age" figures must be true. Moreover, in order not to have been exposed to cosmic rays before it started to fall, each of the meteorites must have been made up of material that was embedded within a solid planet or asteroid.

What could have split the parent asteroid or planets and sent the meteors on their way to ultimately land on the earth? A very real possibility, the scientists conclude, is that there was a huge collision in outer space.

Musings of a Fossilizer

Released from Earth's
  Eternal changing mold,
From sacred, ageless crypt's
  Protective hold,
Things that had life
  Before advent of man,
Breathed of the air
  For brief allotted span,
Enclosed in dust,
  Maybe another's bones
That workmen smile and say,
  Are only stones,
In less than truck load lots
  Not worth a jit
I carefully remove from long
  Abandoned pit,
Place in their proper box,
  And wryly contemplate,
A million ages hence,
  Is this my ultimate?

—Harry B. Smith

* * *

"Why should a man whose blood is warm within,
Sit like his grandsire, cut in alabaster?"

Shakespeare

* * *

Collecting Rocks

I think that there shall never be
An ignoramus just like me,
Who roams the hills throughout the day
To pick up rocks that do not pay;
For there's one thing I've been told
I take the rocks and leave the gold.

O'er deserts wild or mountains blue
I search for rocks of varied hue.
A hundred pounds or more I pack
With blistered feet and aching back,
And after this is said and done
I cannot name a single one.

I pick up rocks where e'er I go,
The reason why I do not know,
For rocks are found by fools like me
Where God intended them to be.

Anonymous

How High Can You Get?

by BEN HUR WILSON

ALTITUDE-WISE, this will depend upon where you are—and for the purpose of this paper, of course, we are referring to points actually upon the Earth's surface.

Do you know where the highest point in your state is? Have you ever visited it?

This really is an interesting question, and does at times infer considerable significance. Elevation and altitude are important geographic and geologic factors. This is particularly true in the matter of divides, (or the *"Heighth-of-land"* as it is shown on Canadian maps), especially when matters of transportation are involved. Divides have always been important geographic barriers, and often form the boundaries between states and nations.

If you wish to have an evening of instructive entertainment, get out a map of U.S.A. and trace on it the major divides and watersheds. You will meet with some surprises, we will assure you. In tracing the Continental and major divides you will find only one spot in North America from which the rainwater may flow into either of three oceans, the Pacific, the Arctic or the Atlantic, depending upon the whim of the wind at the moment of fall. (For an excellent article on this, see "Triple Divide Peak," by Edwin Goff Cook, in May-June, 1954, issue.)

There is another place from which the water may flow into either of two oceans or the Gulf of Mexico. From all other points on continental divides the water has a choice of only two oceans, or the Gulf—which is actually a part of the Atlantic.

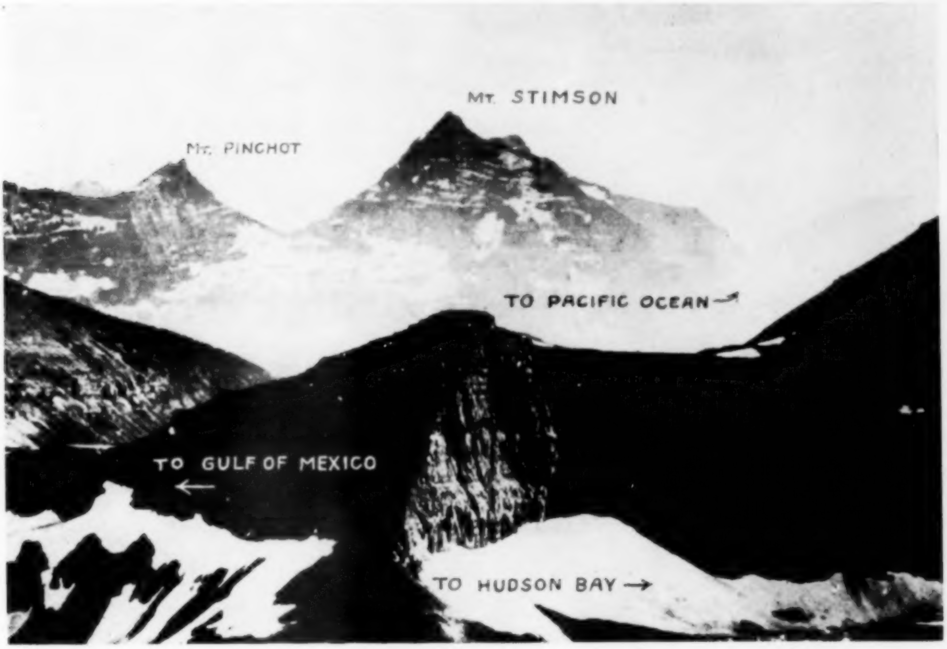
It will also be interesting to note that there are actually several thousand square miles of an area within the United States along our mid-Canadian border that actually drains into the Arctic Ocean, and that the Continental Watersheds are likewise broken down into thousands of individual river basins, large or small, some draining only a few square miles, while others like the "Mississippi - Ohio - Missouri System" drain nearly half of the United States.

You may also be interested in doing the same thing for your own locality or country, in so far as river systems and basins are concerned. Also observe the area of a given lake basin—let us say, Lake Michigan or the Great Salt Lake, noting the relation between the size of the lake and of the basin, and the average annual rainfall of the region. This second problem should keep you interested and also profitably employed on some other rainy evening, if you care to follow up the problem.

In tracing divides on the map remember that they always go around the heads of the rivers, and never cross them, there being only one exception to this that we know of, and that is the place where the Arctic-Atlantic divide crosses the Rainy River dividing the United States from Canada. Here at times this river may run into either of these two oceans, depending upon abundance of rainfall along the course of its head-waters.

Divides, as such, also are important factors in transportation, as they are the "high-roads," or the ridge roads, which early settlers so often had to follow across the country to avoid the lowlands or swampy places, and to be able to avoid unfordable rivers where then there were no bridges. Even today at times divides also control the pattern of modern transportation systems.

When vacation time comes again and you may be traveling about the country, it is sometimes convenient for one to look up and visit the highest point in certain States through which you may be driving, so therefore we are appending the "Official Extreme Altitude" list for the United States, its territories and possessions, for your convenience, furnished us by the Map Information Office of the U. S. Geological Survey, Department of Interior. Copies of this list may be had for the asking. These also give the location of the minimum altitude as well as the maximum.



The culmination of continued drainage as seen from Mount James. Photo: Glacier National Park Service.

EXTREME ALTITUDES IN THE UNITED STATES, ITS TERRITORIES AND POSSESSIONS HIGHEST POINT

State	Name	County	Altitude Feet
Alabama	Cheaha Mountain	Clay-Talladega	2,407
Alaska	Mount McKinley		20,300
Arizona	Humphreys Peak	Coconino	12,655
*Arkansas	Blue Mountain	Polk-Scott	2,800
	Magazine Mountain	Logan	2,800
California	Mount Whitney	Inyo-Tulare	a 14,495
Canal Zone	Cerro Galera	Balboa District	c 1,207
Colorado	Mount Elbert	Lake	14,431
Connecticut	N. Bdy.-Mt. Frissell	Litchfield	2,380
Delaware	Centerville	New Castle	440
District of Columbia	Tenleytown	Northwest part	420
Florida	Sec. 30, T6N, R20W	Walton	e 345
Georgia	Brasstown Bald	Towns-Union	4,784
Guam	Mount Lamlam		a 1,334
Hawaii	Mauna Kea	Island of Hawaii	13,784
Idaho	Borah Peak	Custer	12,655
*Illinois	Charles Mound	Jo Daviess	1,241
*Indiana	Greensfork Township	Randolph	1,240

*Iowa		Osceola	e 1,675
*Kansas	In T15S R43W	Wallace	4,135
*Kentucky	Big Black Mountain	Harlan	4,150
Louisiana	Driskill Mountain	Bienville	535
Maine	Mount Katahdin	Piscataquis	5,268
Maryland	Backbone Mountain Near Kempton, W. Va.	Garrett	3,360
Massachusetts	Mount Greylock	Berkshire	3,491
*Michigan	Porcupine Mountains	Ontonagon	c 2,023
*Minnesota	Misquah Hills	Cook	e 2,230
Mississippi	Woodall Mountains Near Iuka	Tishomingo	806
*Missouri	Taum Sauk Mountains	Iron	1,772
Montana	Granite Peak	Park	12,850
*Nebraska	Epworth Township	Banner	5,340
Nevada	White Mountains Boundary Peak	Esmeralda	13,145
New Hampshire	Mount Washington	Coos	6,288
New Jersey	High Point	Sussex	1,801
New Mexico	Wheeler Peak	Taos	13,151
New York	Mount Marcy	Essex	5,344
North Carolina	Mount Mitchell	Yancey	6,684
*North Dakota	Black Butte	Slope	a 3,468
*Ohio	Campbell Hill	Logan	1,550
*Oklahoma	Black Mesa	Cimarron	4,978
Oregon	Mount Hood	Clackamas-Hood	a 11,245
Pennsylvania	Negro Mountains (Mount Davis)	Somerset	3,213
Puerto Rico	Cerro De Punta	Ponce District	4,389
Rhode Island	Jerimoth Hill	Providence	812
Samoa	Lata	Tau Island	a 3,056
South Carolina	Sassafras Mountain	Pickens	3,560
*South Dakota	Harney Peak	Pennington	7,242
*Tennessee	Clingmans Dome	Sevier	6,642
Texas	Guadalupe Peak	Culberson	8,751
Utah	Kings Peak	Duchesne	13,498
Vermont	Mount Mansfield	Lamoille	4,393
Virginia	Mount Rogers	Grayson-Smyth	5,720
Virgin Islands	Crown Hill	Island of St. Thomas	a 1,550
Washington	Mount Rainier	Pierce	14,408
West Virginia	Spruce Knob	Pendleton	4,860
*Wisconsin	Sugarbush Hill	Forest	e 1,951
Wyoming	Gannett Peak	Fremont	13,785
United States (exclusive of Alaska)	Mount Whitney	Inyo-Tulare, Calif.	a 14,495

NOTE.—These elevations, which give the height of the land above sea level,, unless otherwise stated, were determined by the Geological Survey. Inasmuch as the United States is not entirely mapped, the locations of the highest and lowest points, as well as the values given for some of the points, are doubtful and will be corrected as the areas are mapped.
* States—Affiliated with the Midwest Federation.
a Coast and Geodetic Survey. b Forest Service. c Corps of Engineers. d Soil Survey. e Others.

	Approximate mean altitude Feet	Highest point	Above sea level
North America	2,000	*Mount McKinley, Alaska	20,300
South America	1,800	Mount Aconcagua, Chile-Argentina	22,835
Europe	980	Mount Elbrus, U. S. S. R. Caucasus Mountains	18,468
Asia	3,000	Mount Everest, Nepal-Tibet	29,141
Africa	1,900	Kibo Peak (Kilimanjaro), Tanganyika Ter., East Africa	19,565
Australia	1,000	Mount Kosciusko, New South Wales	7,328
Antarctica	6,000	Mount Markham	15,100

Greatest Pacific Ocean depth, Mindanao Deep (near Philippine Islands) 35,400 feet.
Greatest Atlantic Ocean depth, Milwaukee Depth (near Dominican Republic) 30,246 feet.
Highest insular mountain in the world, Carstensz Mountain (Dutch New Guinea), 16,404 feet.
* It will be noted that Mount McKinley is third highest point in the world.

History of Ideas on the Age of the Earth

Notes by EARL D. CORNWELL

(Resume of a talk by Professor Ailes of the British Geological Survey at the University of Illinois)

IN THE beginning of history, the first mention of the age of the earth had no scientific basis whatsoever. Early theologians based most of their statements on the Book of Genesis. All estimates at this time were in terms of a few thousand years. These teachings, governed primarily by the church at that time, had quite lasting impression upon the thinking and writings of the following generations.

One of the very early publication in this early era actually stated that the earth had been created 4 thousand and 4 years, 6 months and 11 days before the birth of Christ. It was further stated that it was thought to have occurred between the 18th and 20th of October of that year.

It was not until the beginning of the 18th century that writings in general showed that the early influence of the church on this subject had died out. People were beginning to take the initiative to publish their own ideas and thinking.

The English astronomer Edmund Halley, 1656-1742, is credited with being the first actually to publish information regarding the possible age of the earth based entirely upon scientific facts. His statements were based upon the estimated rate of formation of fossils. He also published data based upon the estimated rate of salt-formation in the seas having no outlets. This was in conjunction with a similar estimation of the time required to form the salt concentration of the ocean waters.

During this period of time, considerable study was based entirely upon the structure and composition of sedimentary rocks. Estimates of the age of the earth had now advanced to as much as 100 million years.

New theories were now being injected by a prominent French scientist, based upon the estimated time required for the cooling period of the earth, prior to the beginning of life upon the earth. These theories and publications represent the first definite break with the earlier teachings and influence of the church.

The most outstanding contribution of the 18th century was that by the eminent British geologist, James Hutton, 1726-97, entitled "Theory of the Earth." This work came as the result of long and careful research into geological processes, completed in 1785. This preliminary writing was later amplified and published in 1795 as "The Theory of the Earth, with Proofs and Illustrations." Although it attracted little attention at the time, it later established a place for its author among the foremost thinkers in the realm of geological science. In this publication he ventured the thought of the possibility of geologic-time as being unlimited, based upon his studies of rocks which, to him, appeared to represent time beyond comprehension. One of the fundamental principles of Hutton's theory was based upon the internal heat of the earth, a theory combated by the followers of Werner, a German geologist, 1749-1817, but one which is now generally accepted as correct.

One of the most eminent contributors to geological science in the 19th century was Sir Charles Lyell, 1797-1875. The first volume of his great work, "Principles of Geology," appeared in 1830; the second in 1832, and the third in 1833. Its appearance may be said to mark an epoch in geological science. His contributions are the more remarkable in that his college training had prepared him to be a lawyer and he had been admitted to the bar.

Lyell, justly called the founder of modern geology, was an early advocate, in his first volume, of geological cycles. He was hesitant to estimate length of time intervals, although he eventually published a statement estimating 240 million years since the Cambrian period. This is by far the longest period estimated to this time.

The next outstanding publication was no doubt that of Darwin's "Origin of Species," 1859, with a theory of evolution which in a way was but the logical outcome of Lyell's "Principles of Geology." A statement made by Darwin, relative to our subject, was that, "more than 300 million years had elapsed since the beginning of geologic time."

Following the Darwin theories came those of William Thompson, Lord Kelvin, 1824-1907, a distinguished British physicist. Although he was primarily interested in thermo-dynamics, he

had published papers containing the germ of his theories on the age of the earth as early as 1842. This subject, he constantly discussed and elaborated upon. His writings contain statements ranging as high as 400 million years for the age of the earth. He estimates a period of 100 million years required for the cooling period, prior to the beginning of life on the earth. Kelvin is particularly noted for his doctrines of uniformity in geology.

By the latter part of the 19th century, consirerable time was being spent along the lines of calculations based upon the vast thickness of particular fossil deposits found in the earth's crust.

Similar studies were being made based on the rate of surface erosion and the rate at which the eroded materials were being carried to the ocean beds. All this was then being correlated with the depths of such materials found in different ocean bottoms.

Estimation of the age of the earth was considered by Professor John Joly, an Irish physicist, when he attempted to establish such a figure in 1899, based upon the quantity of sodium found in the ocean waters.

Following statements by Darwin, Huxley, and Spencer, resulting from examinations of fossils found in Cambrian rocks, came the consensus that the over-all age of the earth was undoubtedly far beyond all estimations made to date. It appears certain that no fossils were known in any pre-Cambrian rock during the 19th century. Up to this time, however, each investigator had drawn his own conclusions in a most dogmatic manner.

A new era came into being when it was found in 1896 that uranium, previously discovered in 1789, was radio-active. A couple of years later, it was found that thorium possessed the same properties. By 1903, the relationship between the decrease in mass of uranium and the resulting formation of lead was discovered. From this outstanding discovery, another yardstick was created whereby geologic ages, for the first time, could be calculated on a scientific basis. The only question in scientists' mind at that time, and it still exists today, was whether or not this disintegration and transformation had been going on at the same rate during all of these past millenniums of time. The general consensus, today, is that evidence indicates that this rate has been constant, based upon studies of certain selected minerals over the past 50 years.

As a result of these radio-active studies, it was first estimated in 1914 that the oldest pre-Cambrian rocks were in the range of 1600 millions years old. Today, estimations, based on considerably more data, indicate that the oldest Canadian and South African rocks fall within the range of 2,600 million years of age. This

agrees quite well with that now estimated for meteorites from outer space.

Regarding life on the earth, it is a common consensus that life must have existed before the Cambrian era, which is now estimated at about 510 million years ago.

* * *

One Rockhound to Another

Our paths once crossed
For scarce an hour or so,
Hardly enough to say,
"Hi there," and "hello,"
Yet in that brief encounter,
You and I
Because of kindred int'rests
Forged a tie
That as the days pass by
Would seem to nullify
The formal phrase at parting
Of "good bye."

—Harry B. Smith

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